

III Potsdam-V Kiev International Workshop on Nonlinear Processes in Physics

Organizing Committee:

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The III Potsdam-V Kiev Workshop on Nonlinear Processes in Physics was held at Clarkson University, Potsdam, NY from August 1-11, 1991. It was sponsored by the Clarkson School of Science and was funded by the National Science Foundation, the Department of Energy, the US Air Force of Scientific Research, the US Office of Naval Research, the Sloan Foundation and the School of Science of Clarkson University. The organizing committee was A.S. Fokas, D.J. Kaup, A.C. Newell and V.E. Zakharov.

This was the first major scientific workshop in the USA where the Soviet scientists formed a major contingent of the participants. There were 31 USSR participants out of a total of 106 participants. The emphasis of the workshop was on the interaction between mathematical techniques and problems of physical interest. It was particularly successful in mixing plasma physicists, fluid physicists and soliton theorists. The exchanges between these groups, particularly with the participation of the Soviet delegation, were quite stimulating.

The most difficult part of the organization of this conference was the travel arrangements of the Soviet participants. We appreciate the efforts of Ildar Gabitov in this direction. However, in spite of our efforts several invited Soviet scientists were not able to attend, mainly because of difficulties in arranging their travel to the USA.

For many of the Soviet participants, this was their first visit to the USA. Potsdam, being a small village in the foothills of the Adirondack Mountains, was a particularly pleasing location for their introduction to the Western style of life. There were the occasional luncheons and dinners with local residents as well as interviews with local news reporters. Quite a bit of color was added to the local scene by newspapers using headlines like "The Russians are coming!", "Take a Russian to lunch", etc. There were many other lighter moments during this workshop such as the birthday party for Zakharov and the "Pepsi can accident" ..

Turning to the more serious side, there were up to 11 lectures per day with one and a half days off for excursions. Still there was time in the afternoon for private discussions or a walk



downtown. The lectures ranged from algebraic features of integrable systems and vortex dynamics to applications in plasma physics, ionospheric physics, nonlinear optics, oceanic studies and solid state. It is not possible to give full justice to all the excellent lectures here, but we shall mention some results. Lax presented a survey of the work on the zero dispersion limit for several types of dispersive systems and Levermore, Tian, and Venakides presented new important developments and applications of the Lax-Levermore theory and the associated Whitham's equation. Explicit solutions of this equation, using algebraic-geometric techniques, were presented by Krichever and Dubrovin. Krichever, also reviewed the recent appearance of Whitham's equation in the minimal models of 2D quantum gravity. Another connection between soliton theory and 2D quantum gravity was presented by Its who discussed the role of discrete Painlevé equations and gave a rigorous description of their continuous limit. Deift described a rigorous methodology for studying the long time behavior of the Riemann-Hilbert problems arising in the inverse spectral theory. Santini discussed the possibility of solving purely algebraic equations by the algebraic-geometric techniques developed in soliton theory. New results in the inverse spectral theory of evolution equations in two spatial dimensions was described by Boiti (dromions for DS1), Zhou (KPI), Sung (DSII), and Pogrebkov (KPI). McKean described the spectral theory associated with bi-Hamiltonian structures in classical mechanics, and Dorfman reviewed Hamiltonian and symplectic structures for evolution equations in one and two spatial variables. McLaughlin described algebraic-geometric aspects of the perturbation theory of certain soliton equations. Applications of the dressing method to nonlocal nonlinear evolution equations and to nonlinear evolution equations in multidimensions were discussed by Degasperis and Sabatier respectively. Takhtajan introduced a reversible soliton cellular automaton. Korepin derived and analyzed the integrable PDE's satisfied by quantum correlation functions. Beals described the action angle formulation of the Gel'fand-Dikii hierarchies. Shulman talked about new results regarding degenerate dispersion law. Alber analyzed certain complicated but integrable Hamiltonian systems. Bogoyavlenskij analyzed a certain 2 + 1 version of the KdV and showed that it exhibits the phenomena of breaking of solitons. Conte and Fordy explained how to implement the Painlevé test in the presence of negative resonances.

Grunbaum discussed a novel inverse problem arising in low energy medial imaging (diffuse tomography) and Monk described analytical and numerical aspects of a certain inverse scattering problem. Hasegawa described some of the technical points involved with using solitons as pulses in the proposed transatlantic optical cable and Rupasov described new rigorous results in the quantum theory of stimulated Raman scattering. Bona showed how a rough wave model could give a respectable explanation of the appearance of underwater sand ridges seen on sloping beaches.

Important new results in vortex dynamics was presented by Zabusky, Majda, Ichikawa, Horton and Petviashvili. Norm showed excellent detailed visual descriptions of the collisions and reconnection of vortex filaments while Majda and Ichikawa each independently described the stretching and kinking of vortex filaments in irrotational fluids. Both Horton and Petviashvili discussed the rotational case and in particular, showed that the strength of the vortex determines whether the vortex behaves as a point vortex or a KdV soliton in collisions. Lamgmiur turbulence and collapsing cavitons in the ionosphere were discussed by Don DuBois while Rao and Kaup described how the mode conversion into electron Bernstein waves could cause the quenching of the downshifted peaks seen in the Tromsø and Arecibo ionospheric modification experiments. Morales discussed the nonlinear refraction of an rf wave in the ionosphere while Hada and Hamilton both presented studies of nonlinear Alfvén waves in space plasmas. One of the major presentations in collapse physics was made by Malkin who presented new analytical results for the self-focusing problem

of the two-dimensional nonlinear Schrödinger equation. Zakharov and Rubenchik each discussed aspects of weak turbulence.

Of course there well may be others that should be mentioned also, but the above will serve to give a flavor of the quality and quantity of these lectures.

All the lecturers and titles are listed below. The proceedings of the workshop will be published by Springer-Verlag, hopefully by early 1992. Current plans are to continue this series of workshops, with the next one planned to be held in the USSR in mid-August, 1993.

The Organizing Committee is grateful to the International Program Committee (Beals, Bona, Burke, Grundbaum, Hasagawa, Horton, Krichever, Kruskal, Kuznetsov, Lax, McLaughlin, Mikhailov, Rubenchik, Sabatier, Tabor, Zabusky) for their assistance and important suggestions.

Participants and their contributions

Eitan Abraham Heriot-Watt University, GB	Instabilities in Semiconductor Lasers
Alejandro Aceves University of New Mexico, USA	Chaotic Dynamics for Longitudinally Degenerate Modes in a Ring-Cavity Laser
Solomon Alber University of Nevada, USA	Complex Nonalgebraic Integrable Hamiltonian Systems
Michele Bartuccelli Imperial College, GB	Length Scales and the Navier Stokes Equations
Richard Beals Yale University, USA	Action-Angle Variables for the Gel'fand- Dikii Flows
Keith Blow British Telecom Lab., GB	Quantum Self Phase Modulation in Optical Fibers
Oleg Bogoyavlenskij Steklov Mathematical Institute USSR	Breaking Solitons
Marco Boiti Universita' Di Lecce, Italy	Real and Virtual Multidimensional Solitons
Marco Boiti Universita' Di Lecce, Italy	12 minute movie on Solitons
Jerry Bona Penn State University, USA	Nonlinear Waves and Sediment Transport
Robin Bullough	Quantum Groups: q -Boson Theories of Inter-

UMIST, GB	Models and Applications in Nonlinear Optics
William Burke Geophysics Lab., Hanscom AFB, USA	Nonlinear Model of Supersonic Equatorial Bubbles
Carson Chow MIT, USA	Spatiotemporal Chaos in the Nonlinear Three Wave Interaction
Robert Conte Saclay, FR	The Fuchs-Painleve Test of Nonlinear PDE
Anne DeBouard Universite Paris-Sud, FR	On the Instability of the Static Soliton- Like "Bubbles"
Antonio Degasperis Universita Di Roma I, Italy	Combining Dressing and Nonlocality
Percy Deift Courant Institute, USA	A Steepest Descent Method for Oscillatory Riemann-Hilbert Problems
Charles Doering Clarkson University, USA	Attractor Dimension Estimates for the Incompressible 2D Navier-Stokes Equations
Irene Dorfman Institute of Chemical Physics, USSR	Symplectic and Hamiltonian Structures of Nonlinear Evolution Equations
D.F. DuBois Los Alamos National Lab., USA	Physical Realizations of Strong Langmuir Turbulence in Plasmas
Boris Dubrovin Moscow State University, USSR	Evolution of multivalued functions in dispersive hydrodynamics
Alexander Dykhne Kurchatov Institute, USSR	Low Probability Events, Natural and Manmade
Nikolai Erokhin Space Research Institute, USSR	Self-Similar Models of Unlimited Acceleration of Charged Particles by Strong Waves in Inhomogeneous Plasma
A.P. Fordy Leeds University	Analyzing Negative Resonances in the Painleve Test
Greg Forest	Fully Nonlinear Modulation Equations for Nearly

Ohio State University, USA	Integrable Equations
G. Fraiman Institute of Applied Physics, USSR	On a Relation Within the Theory of Adiabatic Invariants
Ildar Gabitov Landau Institute, USSR	One-Dimensional Defects in the Ginzburg-Landau Equation
Ildar Gabitov Landau Institute, USSR	Ultra Short Pulse Propagation in Active Fibers
J.D. Gibbon Imperial College, GB	Weak and Strong Turbulence in the CGL and Navier Stokes Equations
K.A. Gorshkov Institute of Applied Physics, USSR	Chaotic Scattering of Multidimensional Localized Structures of Nonlinear Fields
P. Grinevich Landau Institute, USSR	The Action of the Vizasoro Nonisospectral KdV Symmetries on the Whitham Equations.
Alberto Grunbaum University of Berkeley, USA	Medical Imaging with Low Energy; A Nonlinear Inverse Problem
E.Z. Gusakov A.F. Ioffe Physico, USSR	Coherent Parametric Phenomena in Inhomogeneous Plasma
Tohru Hada Kyushu University, Japan	Nonlinear Evolution of Alfven Waves
Robert Hamilton UCLA, USA	Formation of Quasiparallel Alfven Solitons
Akira Hasegawa AT & T Labs, USA	Guiding Center Soliton in Optical Fibers
Darryl Holm Los Alamos National Lab., USA	Chaotic Laser-Matter Interaction
Wendell Horton University of Texas, USA	Drift Wave Vortices in Inhomogeneous Plasmas

Yoshi Ichikawa National Institute for Fusion Japan	Solitons on Thin Vortex Filament with Axial Flow
Michael Isichenko University of Texas, USA	Statistical Topography: Fractal Orbits and Turbulent Diffusion
Alexander Its Steklov Institute, USSR Clarkson University, USA	Some Asymptotic Aspects of the Theory of Integrable Systems and 2D Quantum Gravity
Palaniappan Kaliappan N.G.M. College, India	Painleve Analysis and Particular Solutions of the Coupled Nonlinear Reaction Diffusion System
Yukio Kaneda Nagoya University, Japan	Lagrangian Statistics in Two Dimensional Turbulences
Yuji Kodama Ohio State University, USA	Perturbation Method and Optical Solitons
Vladimir Korepin SUNY at Stony Brook, USA	Differential Equations for Quantum Correlation Functions
Igor Krichever Landau Institute, USSR	Algebraic Geometrical Perturbation Theory of Integrable Equations
Martin Kruskal Rutgers University, USA	The Painleve Test and Beyond
Boris Kupershmidt Tennessee Space Institute, USA	Relativistic Analogs of Lax Equations
E.A. Kuznetsov Institute of Automation, USSR	Weak MHD Turbulence
Peter Lax Courant Institute, USA	Dispersive Systems
Jyh-Hao Lee Academia Sinica (Taiwan)	$n \times n$ Zakharov-Shabat System of the Form $\frac{d\psi}{dx} = (z^2 - 1/z^2)J\psi + (zQ + P + R/z)\psi$
David Levermore University of Arizona, USA	Semiclassical Limit for Nonlinear Schrodinger Equations

Yan Guang Li Princeton University, USA	Davey-Stewartson Equation: Curves and Homoclinic Behavior
A. Mahalov Cornell University, USA	Pattern Formation Via Resonant Interactions in Fluid Flows
Andrew Majda Princeton University, USA	Stretching of Vortices in Turbulence and Novel Singular Perturbations on NLS
Vladimir Malkin Institute of Nuclear Physics, USSR	The Analytical Theory for Self-Focusing of Radiation
Dimitrii Manin Rutgers University, USA	Length Scale of Vortices and Mode Competition in Quasi 2D Shear Flows
V.A. Marchenko Ukr. SSR Academy of Sciences	Closure of Sets of Multisoliton Solutions
Henry McKean Courant Institute, USA	Magri's Work on Two Symplectic Structures
David McLaughlin Princeton University, USA	Whiskered Tori for Soliton E4*
Alexander Mikhailov Landau Institute, USSR	Asymptotic Expansions and Integrability
Elinar Mjolhus University of Tromsø, Norway	Numerical Test of a Weak Turbulence for an Electromagnetically Driven Langmuir Turbulence
Semen Moiseev Space Research Institute, USSR	Dissipative Mechanisms of Large-Scale Structures Generation in Fluids
Peter Monk University of Delaware, USA	An Inverse Scattering Problem for Time Harmonic Waves in an Inhomogeneous Medium
George Morales UCLA, USA	Nonlinear Refraction of an HF Wave in the Ionosphere
David Muraki Princeton University, USA	NLS Modulation and Optical Shocks
David Newman	Beam-Driven Langmuir Turbulence in the

University of Colorado, USA	Moderately Magnetized Auroral Ionosphere
David Newman University of Colorado, USA	Ionospheric Langmuir Turbulence Driven by an Electromagnetic Pump Below the Upper-Hybrid Frequency
A.Y. Orlov Shirshov Institute, USSR	Volterra Operator Algebra for Zero Curvature Representation. Universality of KP
Vladimir Petviashvili Kurchatov Institute, USSR	Dynamics of Vortex-Current Filaments in Plasma, Comparison of Experimental Rossby Vortices with the Theory
Len Pismen Technion University, Israel	Interaction of Point Defects in Nonlinear Dissipative Fields
Andre Pogrebkov Steklov Institute, USSR	New Results on 2 + 1 Integrable Systems
Nagesha Rao Clarkson University, USA	Mode Conversions in Ionospheric Heating Experiments
Pedro Ripa C.I.C.E.S.E., Mexico	Success of Arnold's Method in a Hierarchy of Ocean Models
A.M. Rubenchik Institute of Automation, USSR	Weak and Strong Turbulence Coexistence
Valery Rupasov Institute of Spectroscopy, USSR	Rigorous Results in the Theory of Stimulated Raman Scattering
P.C. Sabatier Universite Montpellier II, FR	Extensions of Dressing
Paolo Santini Universita Di Roma, Italy	On the Solution of Certain Systems of Nonlinear Algebraic Equations
E. Schulman P.P. Shirshov Institute for Oceanology, USSR	Analytic Degenerate Dispersion Laws
Vadim Shvets Auburn University, USA	On Superstrong Wave Collapse
Michael Spector	Local and Nonlocal Transfer of Motion

Tel Aviv University, Israel	Integrals in Wave Turbulence
Natalia Sternberg Clark University, USA	Mathematical Modeling in Plasma Physics
Heinz Steudel Zentralinstitut fur Optik Germany	Backlund Transformations as Physical Equations
Li-Yeng Sung Clarkson University, USA	IST for DS II
Grover Swartzlander Naval Research Lab., USA	(2+1) D Spatial Dark Solitons in Nonlinear Optics
Leon Takhtajan Steklov Institute, USSR University of Colorado, USA	Reversible Cellular Automata
Fei Ran Tian Courant Institute, USA	The Whitham Equations, The Zero Dispersion Limit of the KdV Equation
Ladislav Trlifaj Institute of Physics Czechoslovakia	Fluctuating Solitons of the KdV Hierarchy
Stephanos Venakides Duke University, USA	The Toda Shock Problem
Elena Villalon Northeastern University, USA	Interactions of Energetic Electrons and Protons with Whistler Waves in the Earth's Radiation Belts
Stefan Wabnitz Fondazione Ugo Bordoni, Italy	Dynamics of Optical Pulses in a Periodically Twisted Birefringent Fiber Filter
Alexander Wai University of Maryland, USA	Soliton Propagation in Random Medium
John Weiss Arlington, Massachusetts, USA	Periodic Fixed Points of Bäcklund Transformations
John Weiss Arlington, Massachusetts, USA	Wavelets & Two Dimensional Turbulence

Vladimir Yan'kov
I.V. Kurchatov Institute, USSR

Thermodynamics for Linear and
Nonlinear Waves

Norman Zabusky
Rutgers University, USA

Vortex Scattering Paradigm for Reconnection
and Turbulent Intermittency

V.E. Zakharov
Landau Institute, USSR

Integrable Turbulence

Xin Zhou
Yale University, USA

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